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ABSTRACT

This combination teaching guide and student workbook, fifth in a five-volume series (see note), presents an approach to teaching basic welding and welding terms for handicapped students. The teaching guide discusses a functional approach to teaching that can accomodate or alleviate the effects of disabilities. Discussion centers on categories to consider when modifying a course and the CAP (Cognitive, Affective, and Psychomotor domains) model of instruction which includes possible teaching techniques, suggested change actions, and teaching strategies. General comments on how to modify a welding program are also included. The student workbook focuses on electrodes and electrode identification numbers, provides photographs of welding processes and procedures, discusses theory, and furnishes a glossary of welding terms. (CP)

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# THE CAP APPROACH TO MODIFYING VOCATIONAL PROGRAMS FOR HANDICAPPED STUDENTS

## VOL. 5 TRADES AND INDUSTRY WITH AN EXAMPLE IN WELDING

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## Preface

Vocational education for handicapped students provides opportunities for students with disabilities to learn valuable skills and find meaningful employment. A reasonable approach which can be used by vocational teachers to provide instruction and services to handicapped students is needed if all students are to be successful in obtaining employment. Vocational programs can be modified as needed in the trades and industry area in addition to those in agriculture, business, health, and home economics for students with a single disability or with multiple disabilities.

Attempting to modify vocational courses in trades and industry for each disability area would be a monumental task. Such an exercise would not be profitable for either the vocational teachers or the handicapped student. A more reasonable approach is the development of educational strategies which can be used to provide vocational services to a broad range of handicapped students. To help vocational teachers provide these services, the Cognitive, Affective and Psychomotor Model, the CAP model, has been developed. Nearly all disabilities can be categorized under this model which is outlined in the next section. The overall objective of the CAP model is to provide information for vocational teachers on how to modify vocational courses for students with various handicaps.

Along with general categories to consider in modifying vocational programs, consideration must be given to overcoming barriers which may be preventing handicapped students from receiving vocational training. Such barriers may be in the areas of attitude, accessibility, employment, the law, lack of educational resources, and the inability to obtain services. Finally, it must be remembered that the student should be placed in the least restrictive education setting. The least restrictive placement would be in a regular classroom or shop with other students. This type of placement may not be possible, but is desired. If placement in a regular classroom is not possible, then the next least restrictive placement should be made.

The CAP model provides a framework for understanding the many handicapping conditions students may face and can assist the teacher in developing modifications in course materials or teaching strategies when needed. This workbook and tape on Identifying Basic Welding Terms: Electrode Identification Numbers are examples of one lesson modification in the trades and industry area which can be used by some students with disabilities. As you examine the CAP model and this modification example, you are encouraged to think about your own modification strategies.

The Wisconsin Vocational Studies Center wishes to thank Mr. Victor Langer, Instructional Resources Coordinator, and Richard Werwath, Welding Instructor, Milwaukee Area Technical College, Wisconsin for their cooperation in designing and evaluating this modified curriculum in the Trades and Industry area. Further thanks go to Jeff Hamm for developing the audio tape to accompany the workbook.

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PART ONE

*CAP IDENTIFICATION*

The Cognitive, Affective and Psychomotor approach is an attempt to limit the categorical labeling of handicapped students and look at the strengths and needs of individual students. Labeling a student as mentally retarded, visually or physically impaired creates an image of disability and tells nothing about the student's strengths. Labeling is a barrier to learning and employment and does not promote the employable skills which the student possesses.

Furthermore, most handicapped students do not have disabilities which are sharply defined in one disability area. Students labeled as mentally retarded may have learning disabilities, hearing or visual disabilities or any combination of these or other disabilities. Physically impaired students may have emotional, learning or other disabilities.

In addition to the CAP approach there is other information which can assist vocational teachers in modifying their programs. The following list covers categories to consider when modifying a trade and industrial course for handicapped students. Modifications in all categories may not be necessary, however, those modifications needed to help the handicapped student succeed in the regular classroom or laboratory must be made.

*Categories to Consider when Modifying a Trade and Industrial Course for Handicapped Students*

A. Assessment and Evaluation Results

1. Do any exist?
2. Are they available to me?
3. Do I have the skill necessary to utilize them?

B. Students' Employment Goals

1. interests
2. aptitudes
3. prior work experience
4. current functional job skills
5. job skills needed - number and type
6. supervision issues - what is likely to be available vs. what the person needs
7. potential stress factors

8. physical demands
9. transportation factors

C. Occupational Information

1. availability
2. accuracy
3. utility

D. Modification in the School's Physical Plant

1. classroom
2. labs
3. equipment
4. accessibility
5. lavatories

E. Course Content

1. number of objectives - skills - concepts to be taught
2. tasks, subtasks which operationalize objectives
   a) number
   b) success criteria
   c) requisite conditions of performance
3. time constraints
4. reading levels required
5. math levels required, if applicable
6. order of presentation
7. rate of presentation

F. Lesson Plans

1. selection and sequencing of tasks, subtasks
   a) for use by entire class
   b) for use by individual students

G. Text, Manual, Workbook

H. Teaching Materials and Aids for Teacher Use

I. Learning Materials and Aids for Teacher Use

J. Classroom Management Procedures

K. Teaching Procedures

1. for use with entire class
2. for use with the handicapped student on an individual basis; techniques for providing feedback concerning performance

L. Testing Student for Mastery of Course Material

1. content
2. procedures

M. Recordkeeping

1. type
2. quantity

N. Grading and Techniques of Monitoring Progress: Types, Criteria

O. Emotional Climate of Classroom

1. feelings of non-handicapped students
2. feelings of handicapped students
3. teacher's feelings

P. Supportive Services

1. types required
2. availability
   a) in-house
   b) outside agencies

Q. Coordination of Professional Services to Student: Role Definition

1. in-house professionals
2. outside agencies

R. Administrative Policy

1. class placement
2. grading and graduation requirements
3. support services
4. time factors
   a) open entry-exit
   b) fixed enrollment periods
   c) limits for completion

S. Employer Contact - Job Placement: Student's Role

1. job seeking skills
2. interviewing skills

T. Follow-up

1. role definition
2. planning

A review of the above categories shows that much information about the student may be needed to make an intelligent decision on what to modify. The task involves not only an individual teacher but other teachers, administrators, employers, community members and of course the handicapped student. The CAP Model of Instruction provides the change action needed to carry out the modification process.

*CAP MODEL OF INSTRUCTION*

Much difficulty has been encountered by teachers who try to modify each specific course for each specific disability area. There is much overlap in the techniques used and duplication of effort slows down the educational process. The CAP Model deals with the teaching and learning problems encountered in working with handicapped people. The three CAP domains, characteristics of each domain and change action needed for teaching students with disabilities in each domain follow.

*Cognitive Domain*

Cognitive disabilities prevent a student from understanding and learning what is being taught in a trade and industrial program. Persons with full cognitive ability are able to know in a general sense, perceive, remember, judge, reason and recognize. Teachers in the trades and industry area need to be aware of the characteristics of persons who have cognitive disabilities and how to be able to compensate for a lack of cognitive ability. Cognitive disabilities can be observed in the classroom or laboratory setting. Some of these behaviors are listed below along with the change action needed for overcoming or compensating for the behavior.

*Observed Behavior:* *Inability to learn from an auditory, visual or tactile teaching mode.*

*Change Action:*

- Provide learning experiences in more than one mode. Present the material in the course using visual, auditory and tactile modes.
- Visual Teaching Techniques

  Practice having the student visualize in his or her mind the item or concept to be learned.

  Use flash cards. Flash cards are usually thought of as teaching aids for early reading and mathematics courses, but the technique can be used effectively in vocational courses. For example, picture cards showing a sequenced breakdown of the steps needed for replacing a fan belt or installing an additional electric outlet could be developed.

Help the student learn to study by stressing techniques such as underlining with various colors, making notes to themselves, or using acronyms to trigger mind pictures in connection with sequences or lists. Look at words and say them. Use outlines to organize thoughts.

- Auditory Teaching Techniques

  Use cassette tapes to record classroom instruction and let the student use the tapes. Have other students read aloud to the poor reader who is an auditory learner. Have the student try to connect sounds with the material being learned. Say the words or concepts out loud. Read slowly. Try to hear the answer.

- Tactile Teaching Techniques

  Provide hands-on activities so that the student can see and touch the materials or tools you are talking about. Demonstrate the process or task which you wish to teach the student.

*Observed Behavior:* *Inability to use the information given in a correct or acceptable manner.*

*Change Action:*

- Individual practice may be given in making decisions, receiving information and deciding a course of action. Individual guidance through classroom or laboratory situations will help as will role playing and practice in providing acceptable responses to requests.

*Observed Behavior:* *Not able to follow directions.*

*Change Action:*

- Be consistent in giving directions by using the same words and same sequence. If this doesn't work, try giving the same directions in a different format or making a written list of directions. Be sure to have the student demonstrate or provide evidence that he/she knows what you expect.

*Observed Behavior:* *Not able to remember.*

*Change Action:*

- Be systematic. Break the subject material into the simplest tasks and present one task at a time and relate each new task to each completed task. Teach in more than one mode (visual, auditory, tactile). Demonstrate and use examples. Provide repetition in completing the task. Periodically review and show the student the relationship of the task to an actual job situation.

*Observed Behavior:* *Exhibits poor problem solving skills.*

*Change Action:*

- Show the student how to analyze the problem. Show him or her how to identify possible solutions, evaluate these solutions and choose the most appropriate solution. Provide plenty of clues and provide opportunities for successes.

*Observed Behavior:* *Exhibits poor observation skills.*

*Change Action:*

- Point out significant details, similarities and differences. Have students practice doing the same. Prepare and show students examples of poor, acceptable and excellent work. Provide situations and games in which students can practice using their observation skills.

*Observed Behavior:* *Lacks ability to study.*

*Change Action:*

- Techniques used for helping the audio, visual and tactile learner will help. Encourage the student to set aside a time and place to study and help initiate a positive attitude toward study. Provide class time or other supervised study periods. Help students to use short time study periods to accomplish their tasks.

*Observed Behavior:* *Possesses very low reading and writing skills.*

*Change Action:*

- Dramatic improvements in the reading and writing skills of students in secondary and post-secondary trade and industrial class are not likely to occur during the length of the course. The objective should be to improve the reading and writing ability as much as possible. Developing a glossary of words related to the vocational subject area and having the student learn them and their meaning will help the student learn the course material and at the same time enhance reading and writing skills. Enrollment of the student in special reading classes is advisable. If this is done, be sure to: 1) provide the special reading teacher with the glossary of words; 2) inform the teacher of the minimum reading levels which you desire; and 3) explain the problems which you are having in teaching the student.

  The student may not be able to learn to read due to a severe cognitive disability. In this case, use non-verbal teaching modes such as tape cassettes, demonstrations and hands-on activities.

*Observed Behavior:* *Possesses low math skills.*

*Change Action:*

- Like reading and writing skills, low math skills may not improve significantly during the length of the course. It is therefore important that the course time be used to make progress in math skills and do the best possible job in teaching the minimum math needed for the course. In a private conference, explain the needed skills to the student and ask the student to enroll in math instruction which would upgrade his or her skills. Discuss the math requirements of your course with the math teachers and ask them to stress the necessary concepts in their math classes.

*Observed Behavior:* *Completion of tasks is very slow.*

*Change Action:*

- The change action suggested for other behaviors may be appropriate for the slow worker. The optimum level at which a student should perform should be determined. Material which is too easy may not be challenging enough for the student. If the material is too hard, frustration may occur. Develop practice and repetition to speed up work. Keep concepts to be learned to a minimum and reinforce the concepts. The quality of the work should be high even though the quantity is low. Employers demand quality first, but may make some concession on quantity of work.

*Observed Behavior:* *Judgmental ability is poor or lacking.*

*Change Action:*

- The change action techniques used for following directions, problem solving and using information also apply to judgmental ability. Provide activities which will give the student practice in making judgmental decisions.

*Observed Behavior:* *Lack of self-confidence.*

*Change Action:*

- Cognitive disabilities tend to decrease a student's self-confidence. Conversely, helping a student compensate for cognitive disabilities will improve self-confidence. Be sure to provide many successes for the student and use congratulation and praise to reinforce successes.

Students who display one of these behaviors periodically may not have serious cognitive problems. Consistent behavior in these areas denotes a cognitive disability and calls for the evaluation and change of teaching techniques and instructional materials.

*Affective Domain*

Students with affective disabilities may have serious problems relating to other people or to the performance of everyday living and

coping skills. The affective disability may be emotional in nature and interfere with the student's learning process. Affective disabilities are usually not highly visible. There is usually no concrete evidence to suggest the intensity of the disability or to know how long the disability has been present. Recognizing affective disabilities and developing teaching strategies should be a major objective. Poor performance in the classroom may indicate a problem related to depression, interpersonal skills, self-esteem, motivation or drugs. These behaviors are listed below along with change action for overcoming or compensating for the behaviors.

*Observed Behavior:* *Depression. Depression is an affective disorder characterized by lack of emotion, boredom, moodiness, fatigue, slow mental and physical activity and an inability to make decisions. Personal appearance may deteriorate, attendance and classroom performance may drop and the student may withdraw from normal activities.*

*Change Action:*

- Ask the student to come in for a conference to privately discuss his or her classroom performance.
- Try to identify the nature of the depression. It may be as simple as getting more rest and cutting down on extra-curricular activities. Frustrations or a series of frustrations may be causing the problem.
- Listen to the student's perception of the cause of the depression and find out how long the problem has persisted.
- Lend your support to the student. Let him or her know of your concern and that you are willing to help out with the problem. Altering classroom or laboratory situations, providing successful experiences, relieving stress, providing more or less peer interaction, providing time-schedule alterations and alternative paths to the instructional goal may help.
- If the problem persists, help the student seek professional assistance from mental health personnel.
- Volunteer to cooperate with professionals in guidance, mental health and other areas to help overcome the disability.

*Observed Behavior:* *Lack of interpersonal skills. Some lack of interpersonal skills may be manifested as difficulty in dealing with criticism, class disruption, hygiene problems, failure to follow safety and classroom rules and regulations and poor relationships with peers. These problems undoubtedly extend beyond the classroom.*

*Change Action:*

- Do not hesitate to ask for help from community and school resources. These resources may include guidance counselors, special education teachers and administrators.
- Identify the specific problem or area which needs improvement. For instance, Joe does not follow safety rules and is constantly dirty and poorly groomed.
- Evaluate your tolerance level and expectations regarding appearance, social skills and behavior of the student toward peers. Is it realistic for the student to comply to your expectations? Is compliance necessary for classroom functioning or maintaining employment?
- Talk with the student at a private conference and specify your expectations. Let the student know that you expect improvement. Offer your assistance to the student initially and followup that offer periodically.
- Provide positive feedback to the student as progress is made toward solving the problem.
- Confer with other teachers and professionals and work jointly with them to achieve solutions to the problem.

*Observed Behavior:* *Lack of self-esteem. Self-esteem can be described as the extent to which an individual feels good about himself or herself. Students with high self-esteem tend to be confident, assertive, optimistic, persistent and relatively free from anxiety. Students with low self-esteem may question their worth or value as a human being, lack self-confidence, be negative, show anxiety, be failure oriented, seek excessive teacher help and exhibit low classroom performance.*

*Change Action:*

- Improve the student's self-awareness by pointing out strengths and positive qualities.
- Provide the student with success experiences.
- Provide support and encouragement when attempting new or difficult tasks.
- Provide praise for his or her accomplishments.
- Develop opportunities for other students to see and be aware of his or her accomplishments and bring peer recognition to these accomplishments.
- Help the student schedule courses in which he or she can capitalize on strengths.
- If a student has mastered a task, ask him or her to help another who has not mastered the task.

*Observed Behavior:*

*Lack of motivation. Motivation is not easy to define, but it does have much to do with a student's classroom and laboratory performance. Motivation is normally centered around a student's needs, goals, aspirations and ambitions. A student may perform well in a classroom or laboratory because he or she is working toward a vocational goal or some other area held in high esteem.*

*Students who lack motivation may exhibit poor attendance, perform below ability, be highly distractable and have a negative attitude toward work. It would be desirable to have a private conference with an individual exhibiting this type of behavior. At the conference, the student's goals, vocational plans and reason for being in the class should be explored.*

*Change Action:*

- Attempt to show the student the relevancy of the course to future employment possibilities.
- Show, if possible, the progress already achieved by the student.
- Provide encouragement and support to the student and offer to help.
- Make sure that the course content is relevant to the needs of the student.

- Stimulate interest by conducting field trips to business and industrial sites which employ people with the kind of skills which are learned in the course.
- Try alternative ways to motivate students. Consider verbal praise, challenges, individual attention and increasing the responsibilities of the student.

*Observed Behavior:* *Legal drug use. Legal and illegal drugs are being used by your students. The legal drugs may be purchased over the counter or by prescription. Legally prescribed drugs may include barbiturates, sedatives, tranquilizers, antidepressants and amphetamines. These drugs may have side effects upon your students which are visible in the classroom. For example, antihistamines are used to control the symptoms of hay fever. Frequently, drowsiness is a side effect of this drug. Side effects of other drugs may result in blurred or double vision, nausea, memory impairment, coordination difficulties, confusion, nervousness, hyperactivity and thirstiness. It is obvious that any single or combination of these side effects can hinder a student's performance. Hopefully, the teacher will be informed of the use of the drug and the possible side effects.*

*Change Action:*
- Do not suggest that a student discontinue or modify the use of the drug.
- At a private conference, discuss with the student the problems which you have observed. Offer to work with the student and make the necessary alterations in your teaching strategy to help accommodate the student.
- If the use of the drug will create a safety hazard, it may be appropriate to discuss the situation with the student's physician. The discussion should fully inform the physician as to specific safety hazards and the specific student behavior.

*Observed Behavior:* *Illegal drug use. Illegal drugs permeate every section of our society, including our classrooms. These illegal drugs are classified by the effect which they have upon people. The four classifications are depressants, stimulants, hallucinogens and opiates.*

*Behavior of drug users is varied. Some of the same characteristics displayed by the use of legal drugs may be apparent. Other symptoms may be the strong emotional displays, frustration, depression and anger. Loneliness, alienation and impulsive behavior may also be apparent. You may see evidence of thrill seeking and resentment of authority.*

*Change Action:*

- Become knowledgeable about drug abuse, prevention of drug abuse and how to work as an individual in a school setting to assist in decreasing and preventing drug abuse. Contact community associations working to prevent drug abuse.
- Initiate, with the help of other staff and administration, school drug abuse and prevention programs.
- Be a personal non-drug using model to show that lifestyles do not need to include illegal drug use.

*Observed Behavior:* *Use and abuse of alcohol. Alcoholism is the number one drug problem in our schools. Alcoholism is not only the number one school problem but has an equally high abuse rating among staff, parents and community members in general. Absenteeism, deteriorating personal appearance, drop in academic performance, tardiness, decreasing judgment, odor of alcohol on breath and even coming to school intoxicated are indications of alcohol abuse problems.*

*Change Action:*

- Become knowledgeable about alcohol abuse and prevention and learn to work as an individual in a school setting to decrease use and abuse of alcohol.
- Initiate school alcoholism prevention programs to assist students, staff and parents.
- Be a personal example of a successful lifestyle without the use of alcohol.

*Observed Behavior:* *Nicotine ingestion through the smoking of tobacco. Medical evidence concerning the health hazards from smoking tobacco is steadily increasing. Tobacco consumption among school-age students is widespread and is a factor which promotes future health problems.*

*Change Action:*

- Become knowledgeable about the dangers of smoking tobacco. Information can be obtained through the American Cancer Society, State Lung Associations and the American Lung Association. Materials and brochures about smoking tobacco can also be obtained from these organizations for distribution to students.
- Initiate school programs on the hazards of smoking tobacco. Involve and cooperate with other staff and administrators to inform students, staff and parents of the smoking hazards.
- Be a personal example of a successful lifestyle without the use of tobacco.

*Psychomotor Domain*

*Observed Behavior:* *Psychomotor disabilities stem from problems with mobility, stamina, strength, coordination, large and small muscle control, vision, hearing or a dysfunction in brain activity. Health or speech impairments may be included. Psychomotor disabilities restrict a student's performance in the classroom, laboratory and on the job.*

*The main objective in working with students with psychomotor disabilities is to develop teaching strategies, alter the physical environment and develop equipment which helps the student compensate for the disability. Most of the students attending the secondary or post-secondary vocational classes have had their psychomotor disability over a period of time, perhaps all of their lives. These students will be able to express their problems and identify the activities in which they will be able to participate or in which some kind of alteration will be necessary.*

*Change Action:*

- Make appropriate physical facility modifications. This might include modifying doors, doorknobs, water fountains, telephones, providing ramps instead of stairs, bathroom facilities, desks, tables, laboratory equipment and other items to make the classroom and equipment accessible to wheelchair students and students with other limited mobility impairments.
- Provide eyeglasses, contact lenses, magnifiers, telescopic lenses, optical and electronic enlargers and braille marked books for the visually impaired. Use of cassette recorders and typewriters will be helpful for visually impaired students.
- Minimizing unnecessary sounds will help in the instruction of hearing impaired students. Use of sound, vibration and touch will strengthen the instruction. Use of interpreters for the deaf should be provided. Seat hearing impaired students to their best advantage and be sure the teacher stands with the available light shining on his or her face. Use plenty of visual aids and slow the pace of communication when necessary. Give a non-hearing impaired student a carbon paper to take notes for a hearing impaired student. Glossaries of difficult words should be provided ahead of classtime to allow for familiarization of course terminology.

*MAKING THE CAP MODEL WORK*

Developing successful programs for handicapped students in the trades and industry area will take additional time and finances. It will be necessary for the teacher to work closely with the handicapped students and involve administrators, employers and parents in the process. Open entry and exit courses are desirable. This will alllow sufficient time for handicapped students to complete the task of learning employable skills.

Handicapped students need to know what is expected from them in the classroom and on the job. Employers expect quality work from their employees and handicapped persons should be expected to maintain quality. However, some concession on the quantity of work may be tolerated for a select period.

Job placement for handicapped students needs to be explored early in the course of the student's vocational program. Handicapped students, especially those with learning impairments, will require more time in learning employable skills. It is important that time not be spent in teaching outdated skills or skills which are not employable. Cooperation between the teacher and employer will help the teacher to develop a curriculum which will provide the handicapped student with employable skills.

Teachers can work with employers to help redesign jobs around the tasks which the handicapped student can do. For example, if a job contains twelve tasks and the handicapped student can do only eight, the job could be restructured around those eight tasks. The remaining four tasks could be performed by a non-handicapped employee. Job redesign is relatively new and holds much promise as a method of achieving employment for handicapped students.

The Cognitive, Affective and Psychomotor domains of the student cannot be isolated when planning vocational programs. The student's strengths in each CAP area must be utilized to develop a vocational program which provides the handicapped student a chance to learn employable skills.

## *MODIFYING A WELDING PROGRAM*

### *Identifying Basic Welding Terms: Electrode Identification Numbers*

This modified lesson introduces students to the identification numbers on electrodes used in basic welding. The text explains that each number on the electrode presents basic information to the welder. Pictures and charts accompany each new idea presented in the lesson. In explaining identification numbers, the lesson also discusses welding terms including basic welding positions and types of electrical current. Additional pictures and diagrams present information about the welding process.

### *Prerequisite Skills*

This lesson was designed specifically to assist students with limited cognitive skills. These students could become successful welders, but might face problems using traditional welding textbooks. Other students with disabilities in the affective or psychomotor domain may also learn more readily by using this textbook and audio tape.

To use this lesson most effectively, the student must be able to recognize numbers. Students will also need an eighth grade reading level and may need to use the glossary at the end of the workbook frequently because of the technical nature of welding terms. No previous knowledge of welding is necessary, but it is important that the student is able to observe and handle welding equipment, supplies, and some finished welding products. A student with these skills and experiences should be able to recognize most basic welding terms and visuals when combined with the audio explanation.

### *Objectives/Evaluation*

By following the lesson the student should be able to: 1) explain what the numbers on an electrode represent; 2) recognize four basic welding positions; 3) understand the difference between direct and alternating current; 4) understand straight and reverse polarity; and 5) understand the basic welding process of fusing the electrode and the base metal.

After each part of the lesson, the teacher is encouraged to question the student or to present a flash card exercise to determine his or her understanding of welding fundamentals and electrode identification numbers.

*Designing Modifications*

For this lesson we chose to use a workbook and an audio tape as one way to present information about basic welding terms. The workbook can be used independently by a student who learns more effectively in a visual mode.

In modifying your teaching materials on a tight budget, you may wish to use charts or drawings rather than photographs in a workbook. Or you may choose to work with a student photographer, with your department providing the film and lab fees and encouraging the student to contribute his or her photography and developing time. The audio tape which accompanies the workbook can be produced or reproduced at minimal expense. Students in English or Communications classes might prepare scripts and several tapes for your lessons as part of a class project.

*Instructions for Using this Lesson*

The teacher will need to assess each student's most effective learning mode (e.g., visual, auditory, tactile). Then the teacher will need to present the workbook and/or tape in the most effective manner.

First, the teacher can explain the purpose of the task and orient the student to the materials and procedures. The tape runs 13 1/2 minutes and can be stopped as needed when a student wants to spend more time reading the text or looking at the photographs or diagrams. On the tape, at the end of each page there is a "beep" which indicates that the student should go to the next page. The teacher may be available to answer questions during the lesson or may choose to have the student mark any confusing areas and ask questions after the lesson.

Student Workbook

V. 5 Trades and Industry with
An Example in Welding

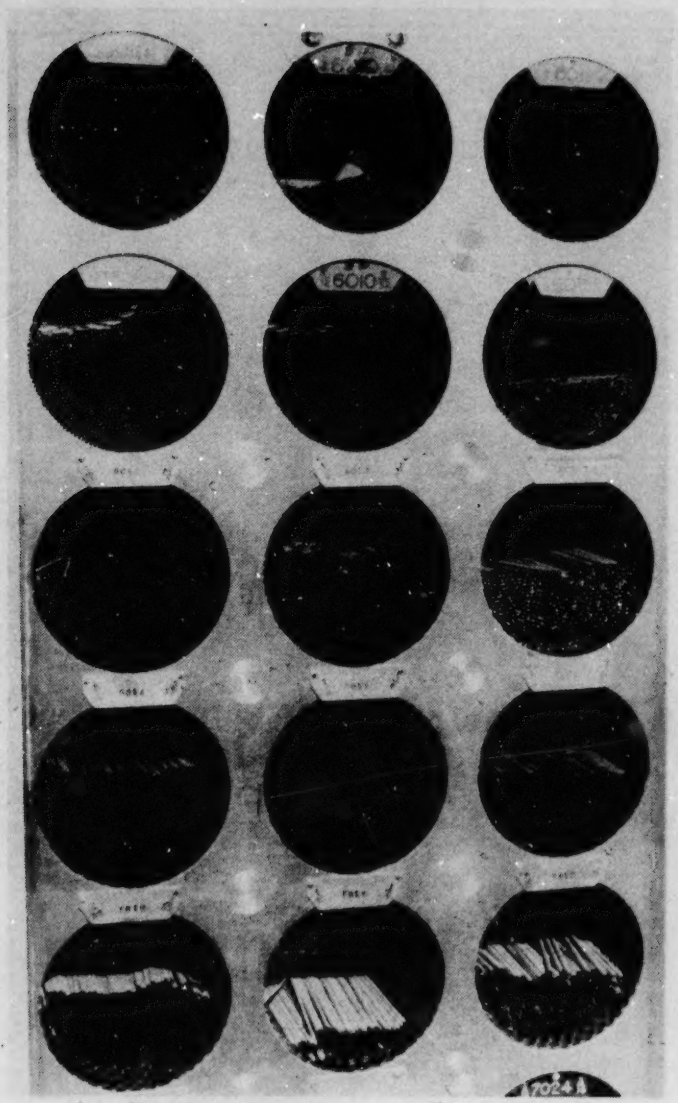
Identifying Basic Welding Terms:

# Electrode Identification Numbers

## Workbook and Audio Tape

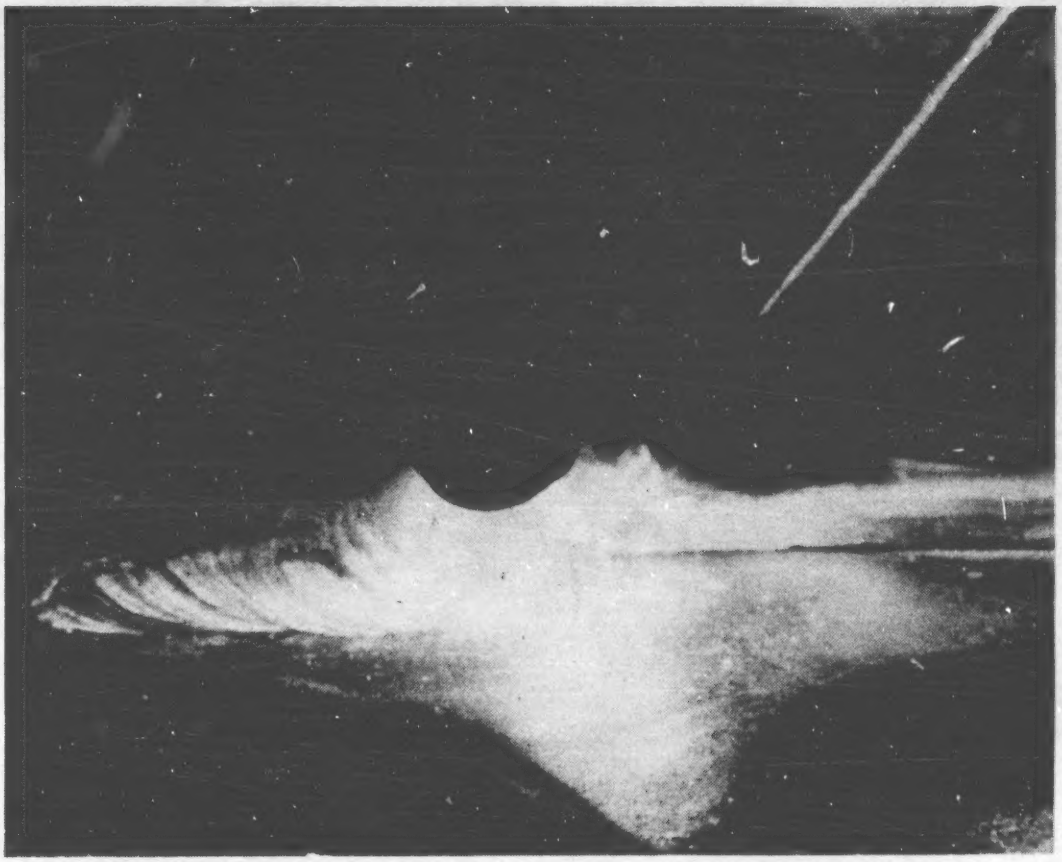
*Instructions for Students:*

*This tape runs 13½ minutes and can be stopped if you want to spend more time reading the text or looking at the photographs or diagrams. On the tape, at the end of each page there is a "beep" which indicates that you should go to the next page. Now, turn to page 1 and start the tape.*




This presentation will teach you about electrodes and electrode identification numbers. All electrodes have identification numbers. This picture shows part of a typical electrode storage container. These identification numbers help the welder pick the best electrode for the welding job. There are so many different kinds of electrodes that unless you pick the right one you will have difficulty doing a good welding job.

Electrodes are filler metals in the form of wires or rods. It is important that the welder select an electrode with nearly the same makeup as the metal to be welded. This picture shows the gap which is about to be filled as the electrode melts. The metal to be welded is called the base metal.



When heated, the electrode and the base metal under the electrode's arc melt and flow together in a liquid like pool. This melting together is called fusion. The melted metal then cools and hardens, holding the two pieces of metal together.

Since welders work in different positions and with different types of metals and power sources, it is important that they choose the most suitable electrode for the job. This person needs a special type of electrode in order to do a good repair job on this machine grinder.

# E6012

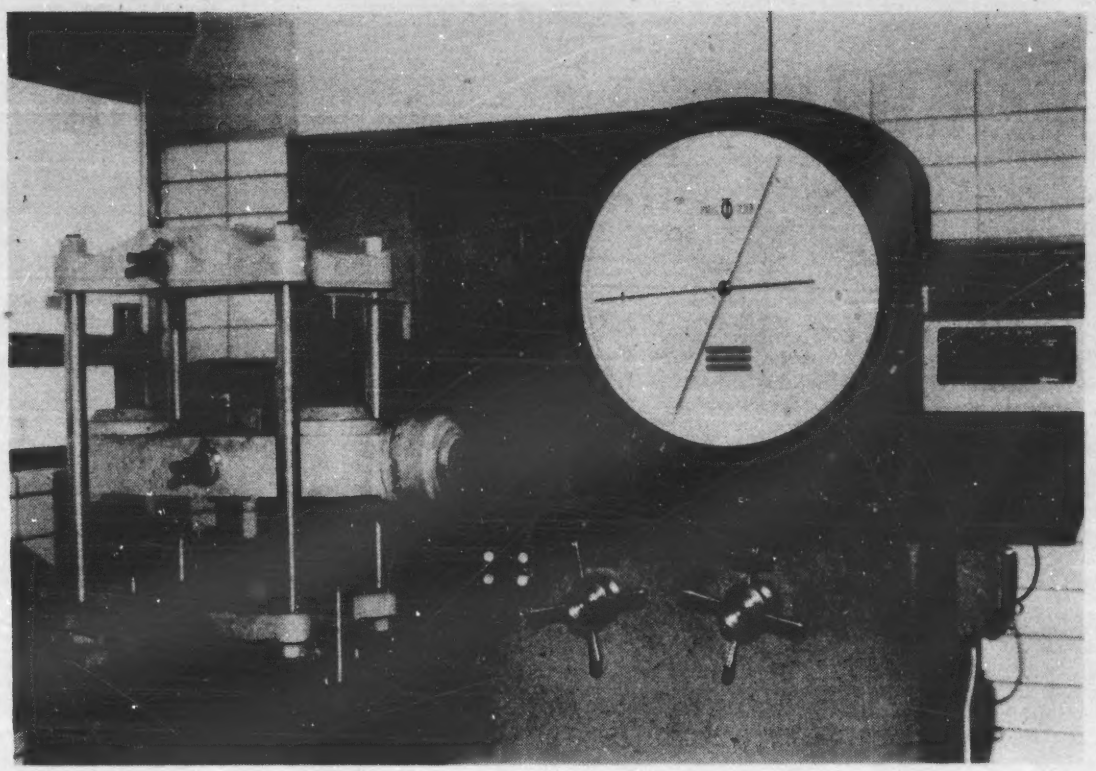
# E12024

The electrode indentification number which helps the welder pick the best electrode for the job, always has four or five numbers following the letter E. The letter E indicates that the electrode is a metal arc welding electrode.

# E6014

# E11013

The first two or possibly three numbers after the letter E tell the welder about the electrode's tensile strength or how much pulling pressure it can withstand before it breaks. The minimum amount of pressure that a welded electrode can withstand before it breaks is called tensile strength.



An electrode's strength is determined by a tensile testing machine. This machine pulls at a welded electrode gradually increasing the pulling pressure until the electrode breaks. The tensile testing machine registers the amount of pressure that the electrode can withstand before it breaks. On this machine the pressure is registered on the large glass covered dial with the watch-like hands. This amount of pressure is registered in thousands of pounds per square inch or p.s.i.

| Electrode Number | Tensile Strength |
|---|---|
| E8014 | 80,000 |
| E12021 | 120,000 |
| E9013 | |

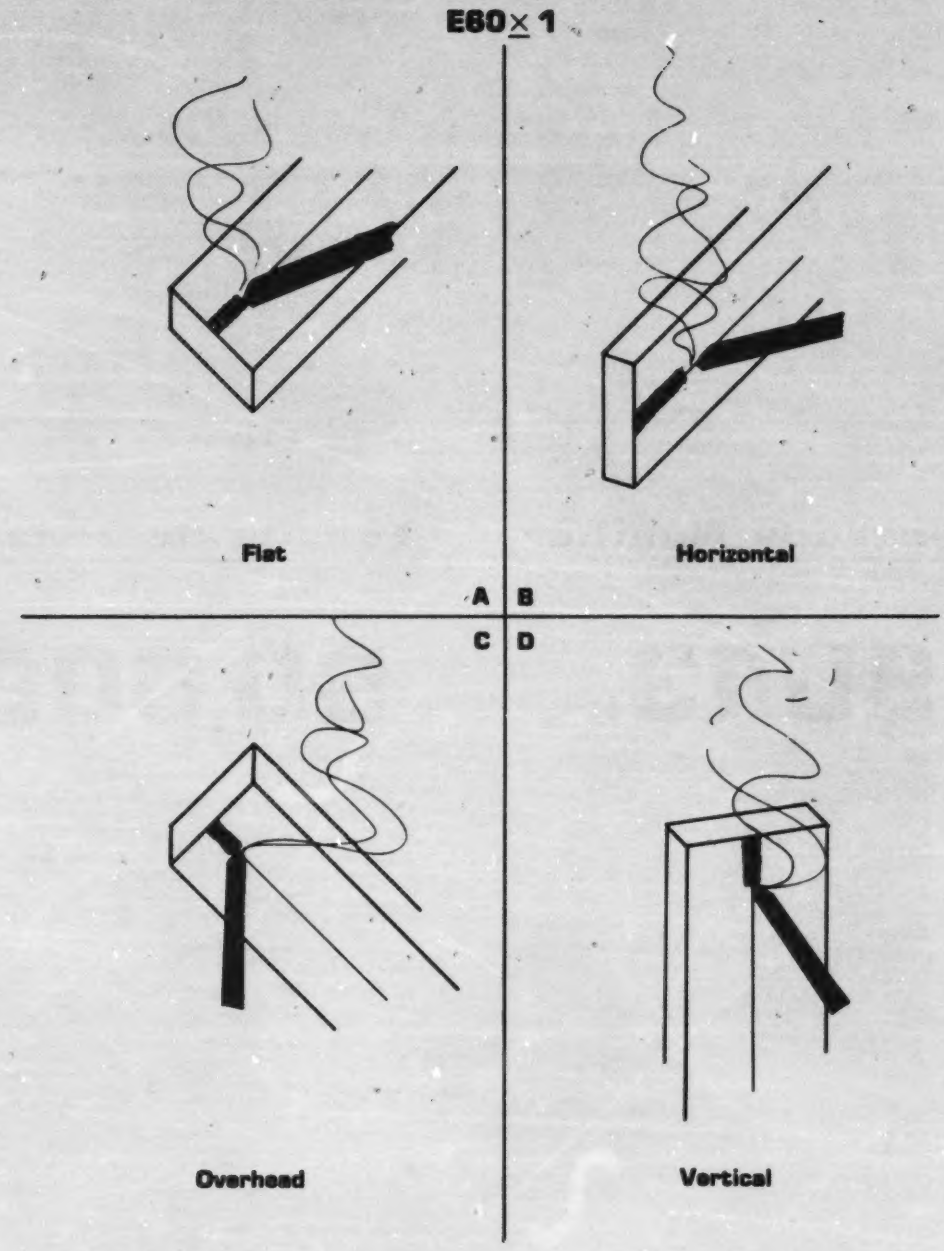
Here are some examples. In the first example, E, eight, zero, one, four, the first two numbers are eight and zero. This tells the welder that the tensile strength is 80,000 pounds per square inch. This means that this electrode could be used in welding situations which did not involve a pulling pressure of over 80,000 pounds per square inch.

In the next example E, one, two, zero, two, one, the first three numbers are one, two, and zero. This means that the tensile strength is 120,000 pounds per square inch.

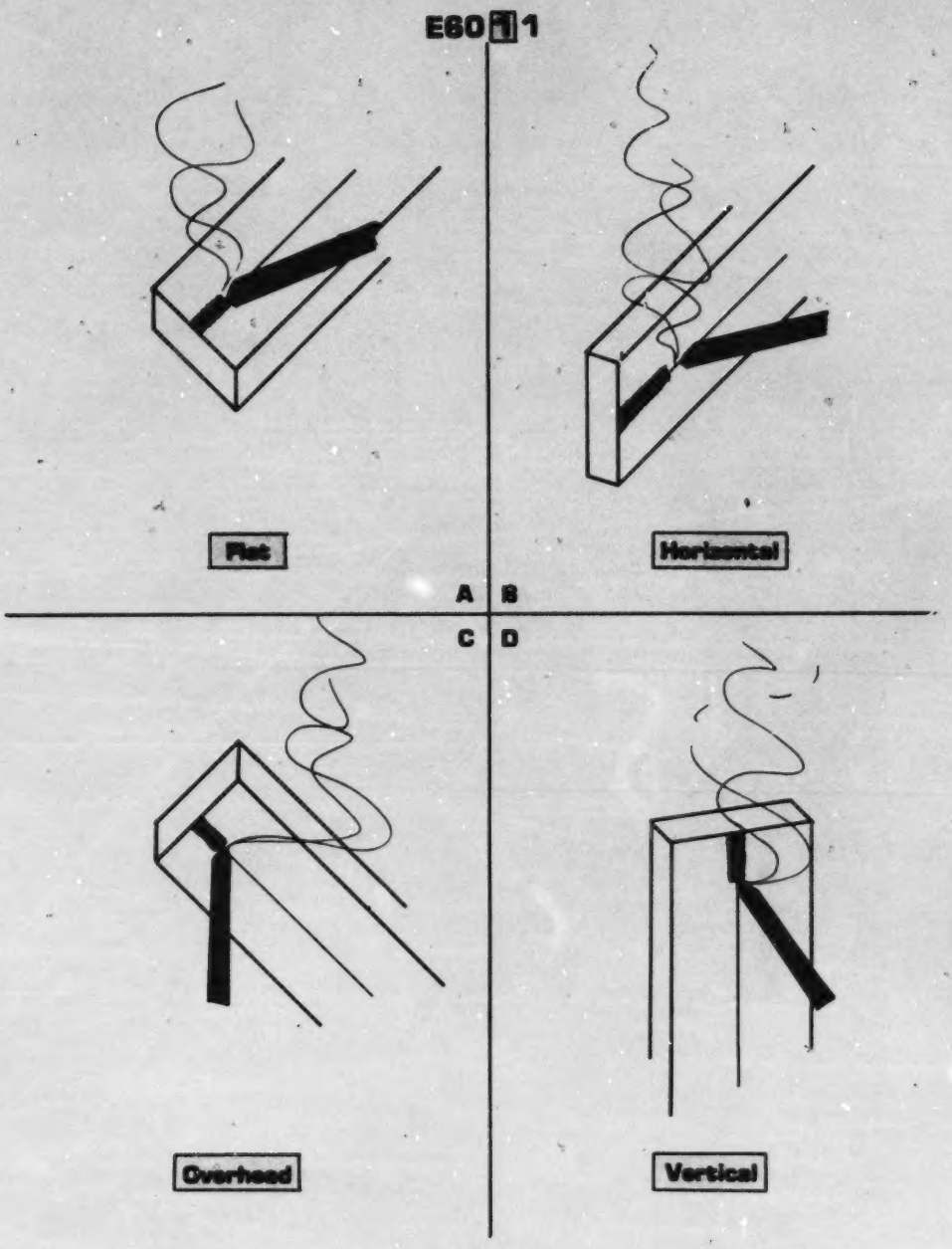
Look at the last example, E, nine, one, three. What is the tensile strength?

| Electrode Number | Tensile Strength |
| --- | --- |
| E9013 | 90,000 |

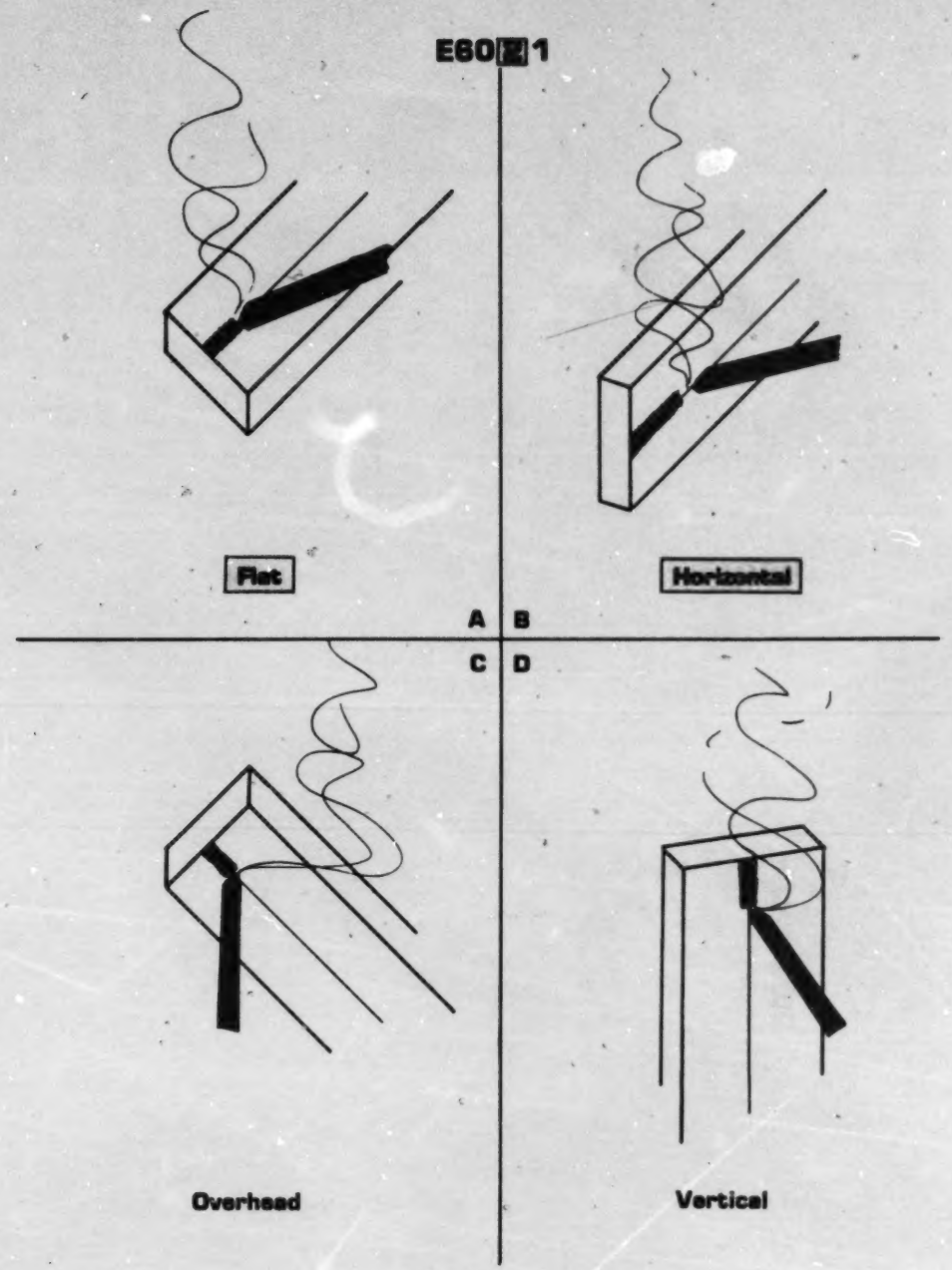
If you said 90,000 pounds per square inch, you are right.




The second last number tells the welder in which positions an electrode can be used. There are four welding positions. Box A shows the flat position, box B the horizontal position, box C the overhead position, and box D the vertical position.



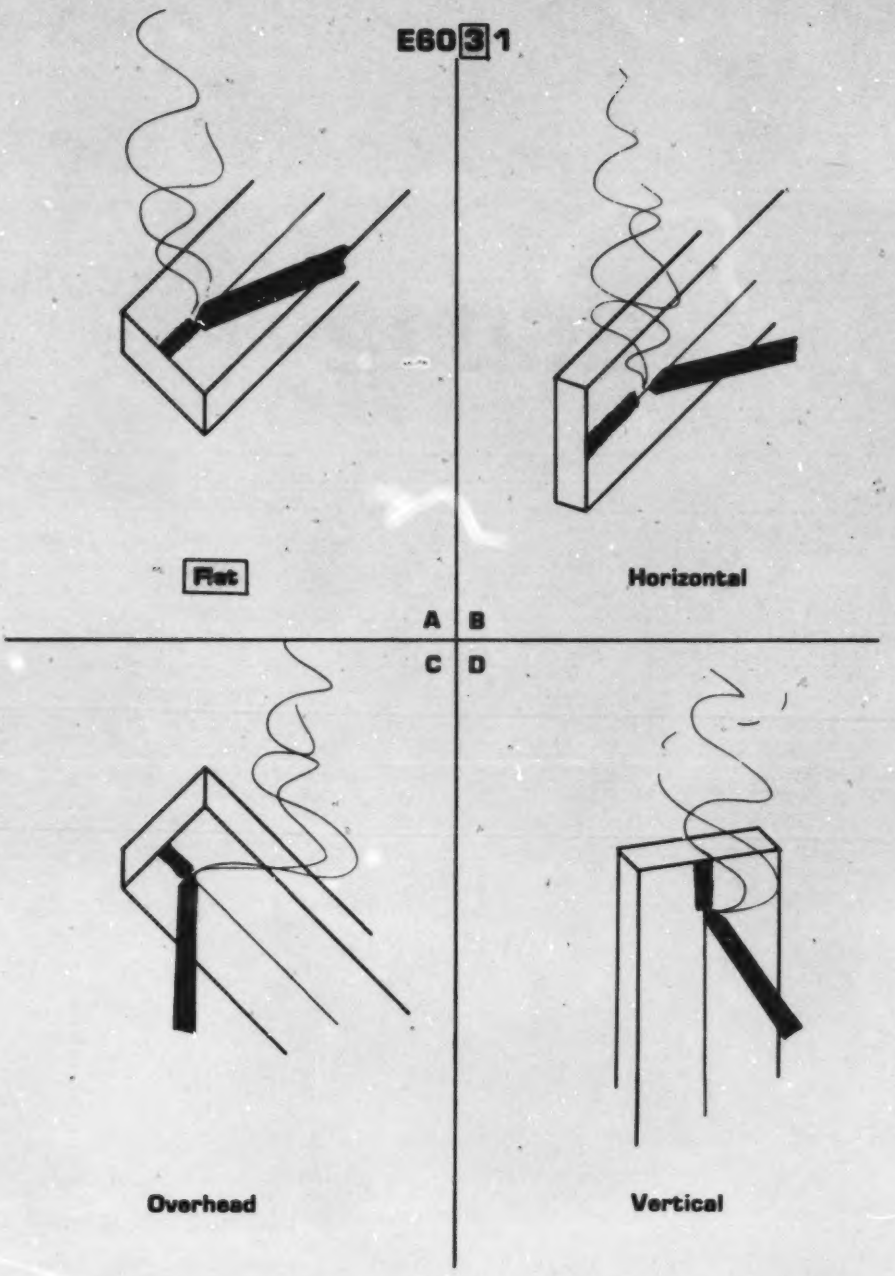

The number one means that the electrode can be used in the flat, horizontal, overhead or vertical positions.




The number two indicates that the electrode can be used in the flat and horizontal positions.



[12]




The number three indicates that the electrode can be used only in the flat position.

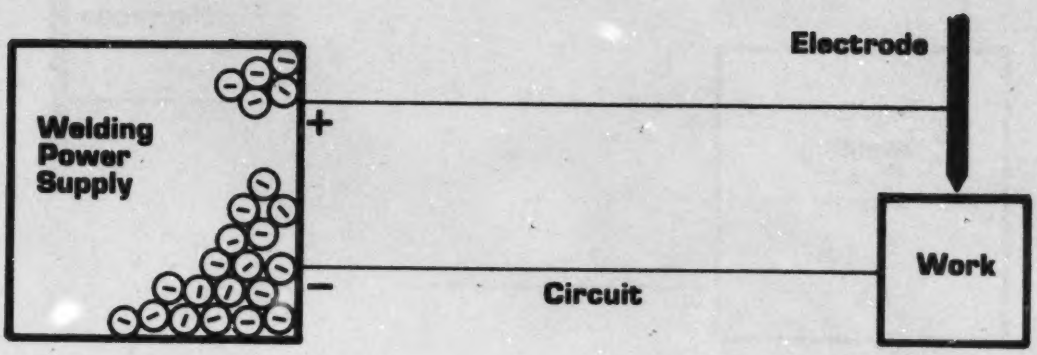
# E6012

| Classification | Current | Arc | Penetration | Covering & Slag | Iron Powder |
|---|---|---|---|---|---|
| EXXX1 | AC & DCRP | Digging | Deep | Cellulose-potassium | 0 |
| EXXX2 | AC & DCSP | Medium | Medium | Rutile-sodium | 0-10% |
| EXXX3 | AC & DCS & R | Soft | Light | Rutile-potassium | 0-10% |
| EXXX4 | AC & DCS & R | Soft | Light | Rutile-iron powder | 25-40% |
| EXXX5 | DCRP | Medium | Medium | Low hyd.-sodium | 0 |
| EXXX6 | AC or DCRP | Medium | Medium | Low hyd.-potassium | 0 |
| EXXX8 | AC or DCRP | Medium | Medium | Low hyd.-iron powder | 25-40% |

The last digit of the electrode identification number gives the welder further information about the electrode. The last digit combined with charts from the American Welding Society or electrode manufacturers, tells the welder about how the electrode may be used.

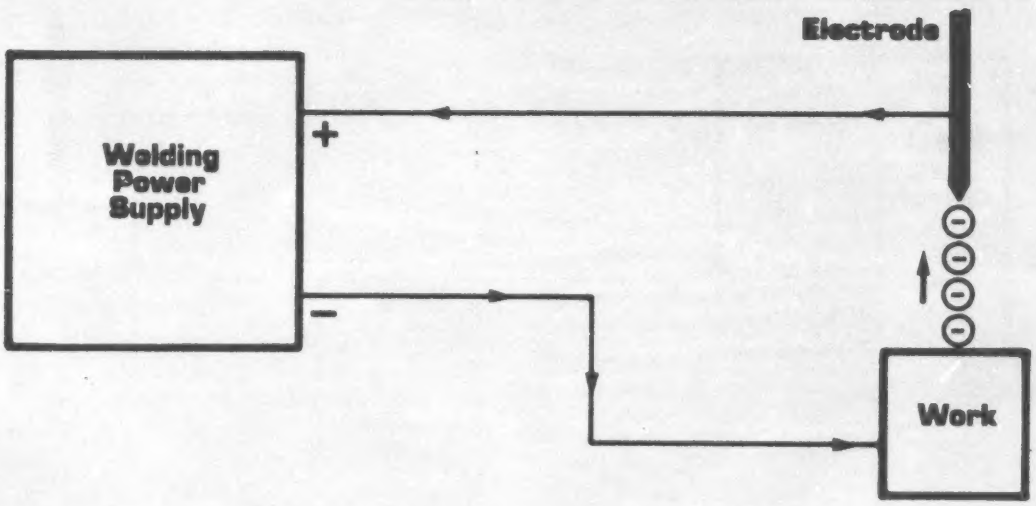
For example, if the last digit was two it would mean; the electrode could be used with A.C. (alternating current), or D.C.S.P. (direct current with straight polarity), the type of arc and penetration is medium, the covering is rutile and the slag is sodium, and the iron powder is between zero and ten percent.

Now we will explain what is meant by current, arc, penetration, covering and slag, and iron powder.



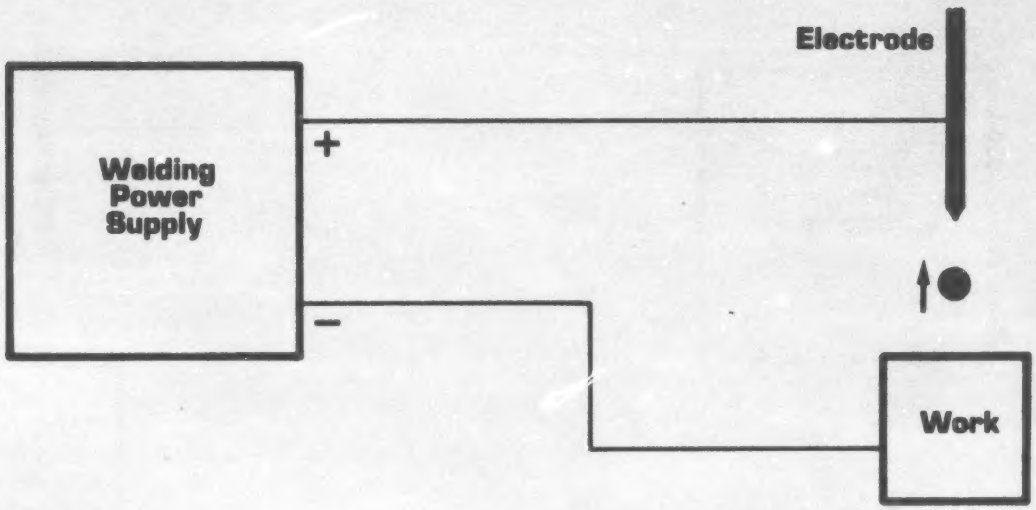

First we'll explain the welding power supply. Electrical current is the flow of negative charges called electrons through a circuit. The electricity starts from the negative terminal of the welding power supply, where the current is produced, moves along the circuit through the work and then returns to the positive terminal. Think of the welding power supply as making electrons which are piled up at the negative end of the terminal. The positive end of the terminal never has enough electrons and the negative end of the terminal always has too many electrons. When the two terminals are connected to each other by a circuit, the electrodes from the negative terminal travel to the positive terminal.

## DIRECT CURRENT (D.C.)



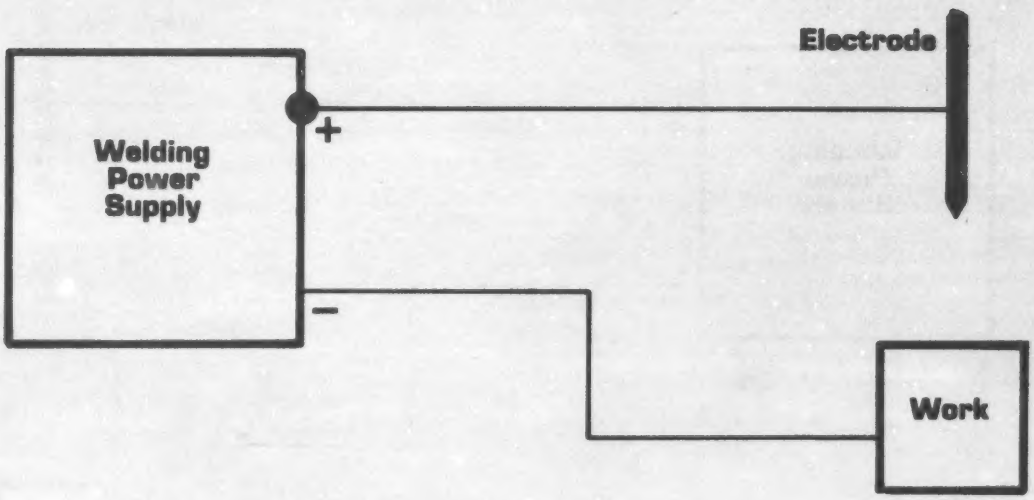

When these negative charges called electrons flow in the same direction all the time, the current is called Direct Current or D.C.

## ALTERNATING CURRENT (A.C.)



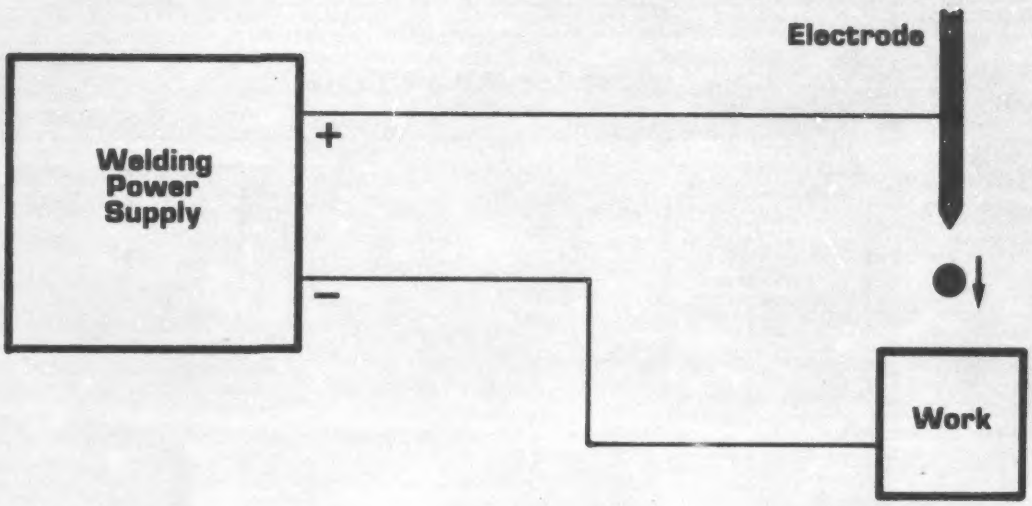

When the current changes direction back and forth, first flowing from the negative to positive terminal....

## ALTERNATING CURRENT (A.C.)



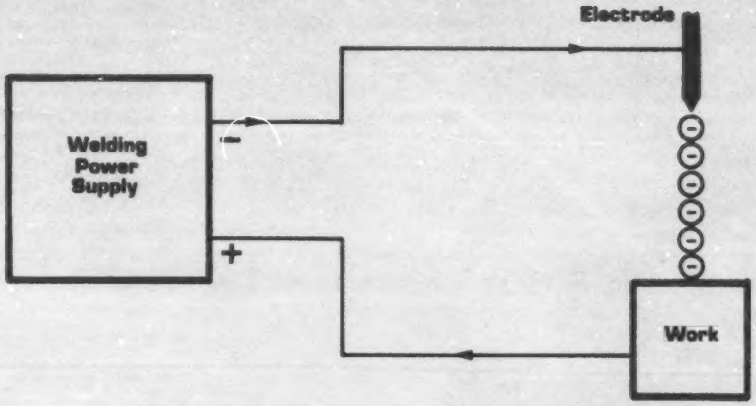

....then stopping at the positive terminal....

## ALTERNATING CURRENT (A.C.)

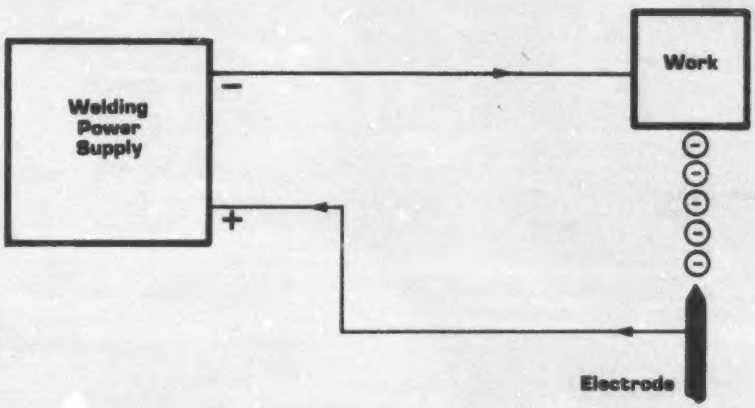



....and coming back to the negative terminal, the current is called alternating current or A.C.

## STRAIGHT POLARITY (S.P.)



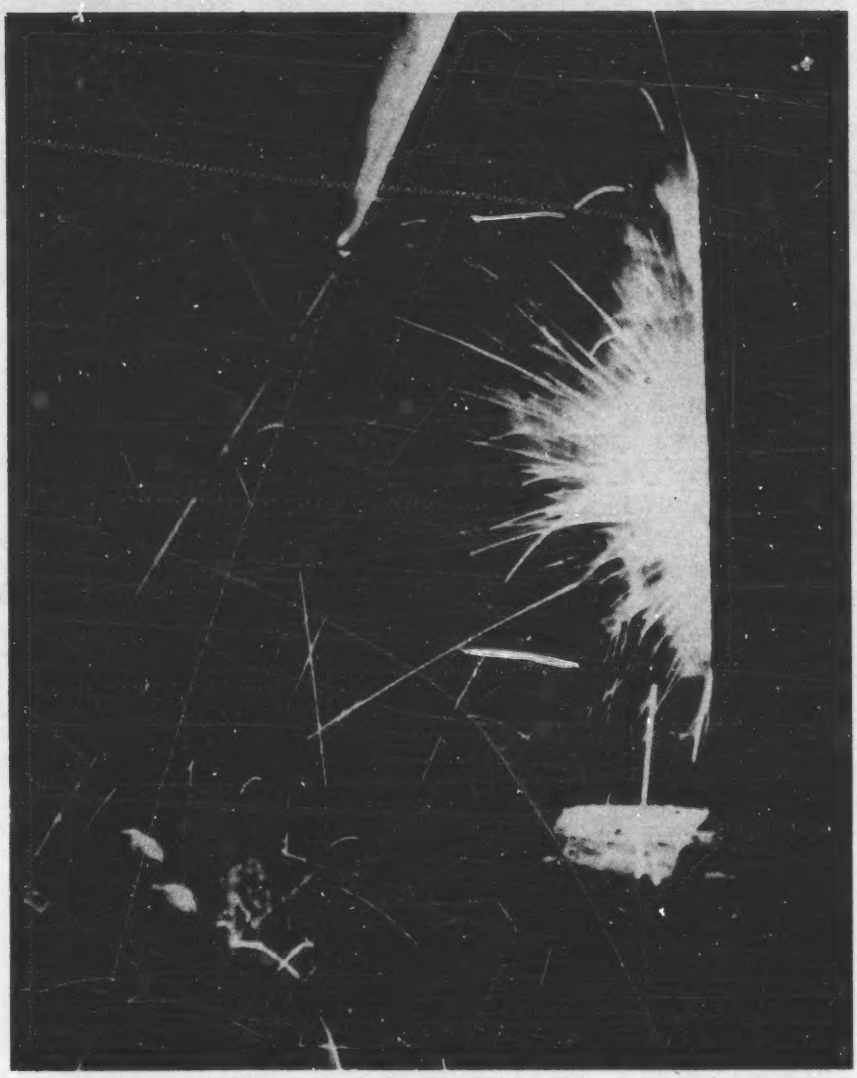

## REVERSE POLARITY (R.P.)



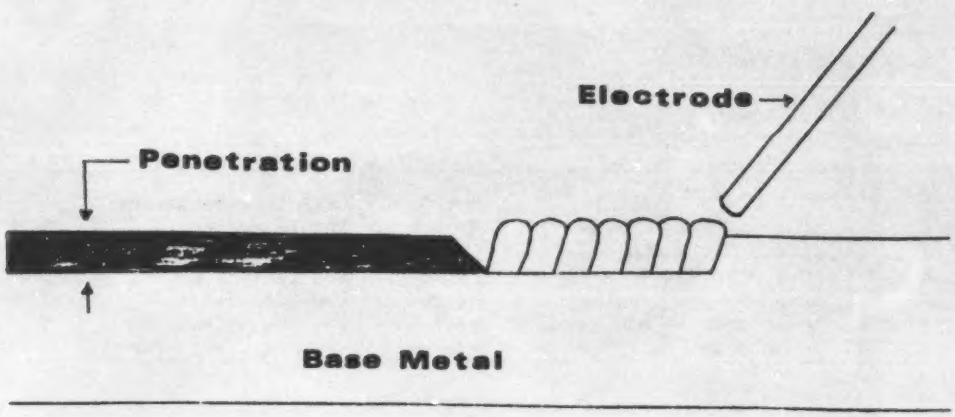

The polarity of the current is the direction that the current flows. Polarity only refers to direct current. Look at the top picture. When the current runs from the power supply to the electrode and then through the work, the circuit has straight polarity. Now look at the bottom picture. When the current first runs from the work to the electrode, its circuit is said to have reverse polarity. The type of polarity affects the arc's heat. When the electrode is attached to the negative terminal like the top picture the circuit has straight polarity. When the electrode is connected to the positive terminal the circuit has reverse polarity.

| Classification | Current | Arc | Penetration | Covering & Slag | Iron Powder |
|---|---|---|---|---|---|
| EXXX1 | AC & DCRP | Digging | Deep | Cellulose-potassium | 0 |
| EXXX2 | AC & DCSP | Medium | Medium | Rutile-sodium | 0-10% |
| EXXX3 | AC & DCS & R | Soft | Light | Rutile-potassium | 0-10% |
| EXXX4 | AC & DCS & R | Soft | Light | Rutile-iron powder | 25-40% |
| EXXX5 | DCRP | Medium | Medium | Low hyd.-sodium | 0 |
| EXXX6 | AC or DCRP | Medium | Medium | Low hyd.-potassium | 0 |
| EXXX8 | AC or DCRP | Medium | Medium | Low hyd.-iron powder | 25-40% |

The next two areas on the chart are arc and penetration. These two qualities of the electrode are related so we will talk about these together. The type of arc and amount of penetration are mainly caused by the electrode's coating and the type of polarity.



The arc is the bright hot glow between the electrode and the base metal. The arc is made when the electrical current has to jump through the air between the electrode and base metal. As the current goes through the air it becomes hot and glows.

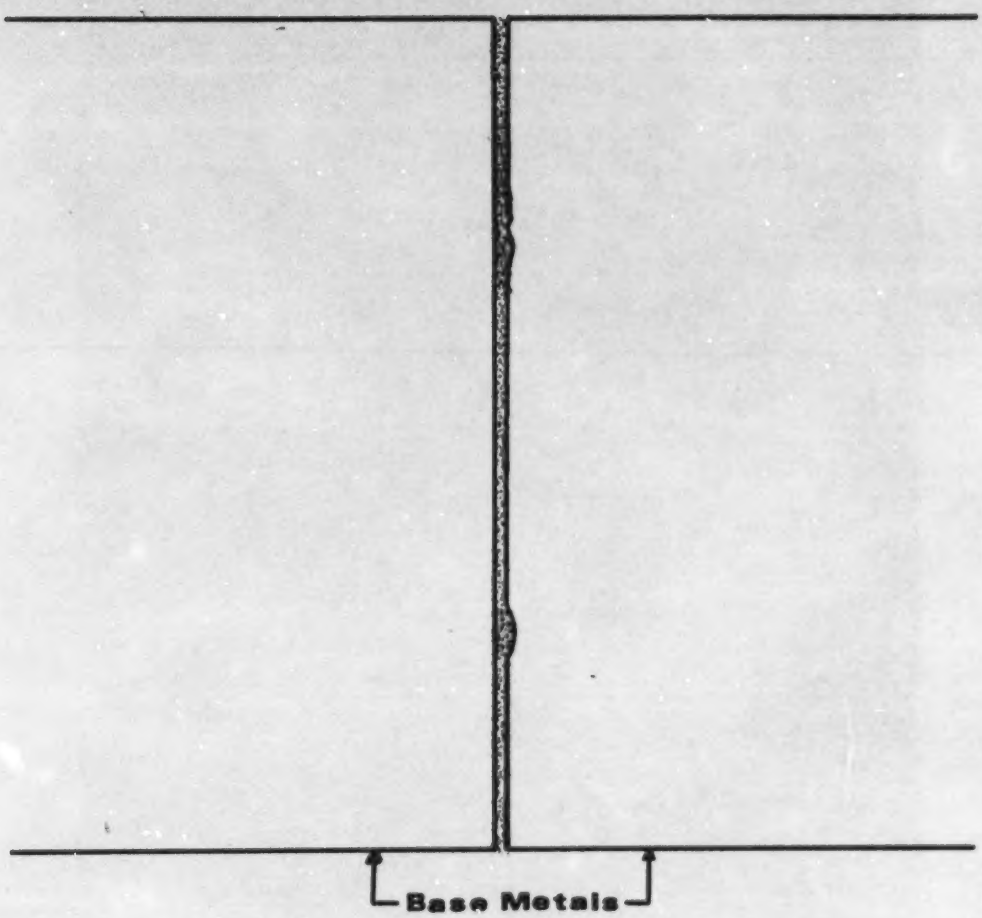



The penetration is the depth of the welding fusion or how deep into the base metal the electrode and base metal melt. This picture shows a side view of a welded piece of metal. The penetration is how deep the electrode and the base metal melted together. In this picture the shaded area between two arrows is the penetration. It is the distance from the top of the base metal to the bottom of the welding fusion.

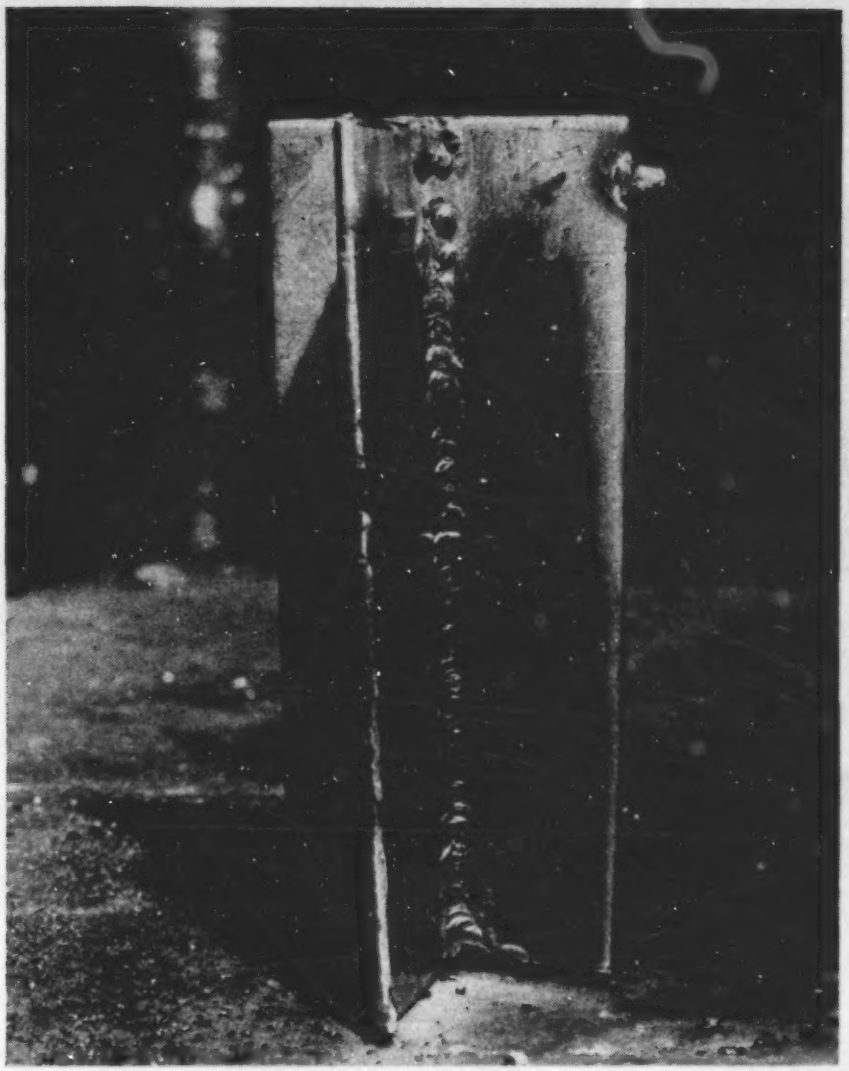
| Classification | Current | Arc | Penetration | Covering & Slag | Iron Powder |
|---|---|---|---|---|---|
| EXXX1 | AC & DCRP | Digging | Deep | Cellulose-potassium | 0 |
| EXXX2 | AC & DCSP | Medium | Medium | Rutile-sodium | 0-10% |
| EXXX3 | AC & DCS & R | Soft | Light | Rutile-potassium | 0-10% |
| EXXX4 | AC & DCS & R | Soft | Light | Rutile-iron powder | 25-40% |
| EXXX5 | DCRP | Medium | Medium | Low hyd.-sodium | 0 |
| EXXX6 | AC or DCRP | Medium | Medium | Low hyd.-potassium | 0 |
| EXXX8 | AC or DCRP | Medium | Medium | Low hyd.-iron powder | 25-40% |

As you look back at the chart you can see that there are three types of arcs (digging, medium, and soft) and three types of penetration (deep, medium, and light).

Electrodes with digging arcs and deep penetrations make a narrow and deep fusion into the base metal. These electrodes also freeze fast which means that the fused or melted metal hardens quickly. Because the fusion hardens quickly these electrodes are very good when welding in the overhead and vertical position. In this picture an electrode with a digging arc and deep penetration is being used. Notice that the melted metal stays on the base metal instead of dripping or running off. These electrodes are also used when welding thick pieces of metal because the digging arc penetrates deeply into the base metal making a strong weld.



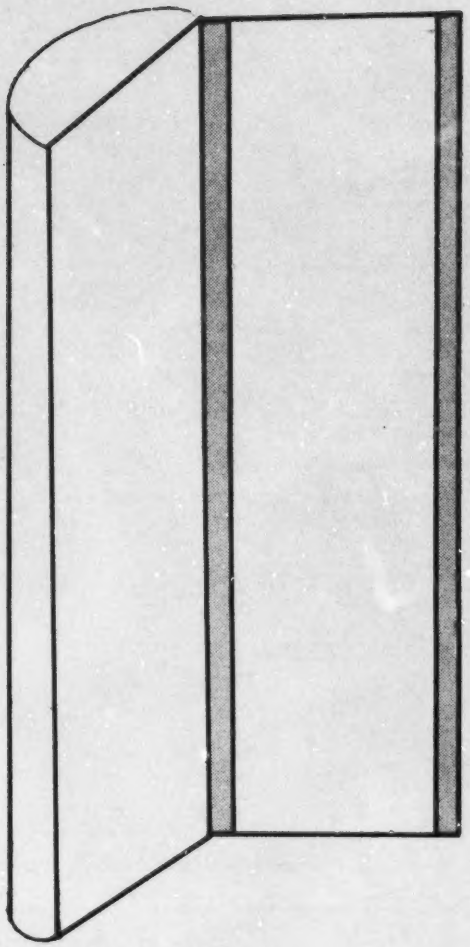

Electrodes with medium arcs and penetration are frequently used when welding pieces of metal together which do not fit together evenly. Perhaps the pieces of metal to be welded have gaps or jagged edges. This drawing shows one piece of metal with a straight edge and one piece which has rough areas. The shaded areas show where the medium arc and penetration would be helpful. Electrodes with medium arcs and penetration are good fill electrodes since they will spread out filling the gaps rather than digging deep.



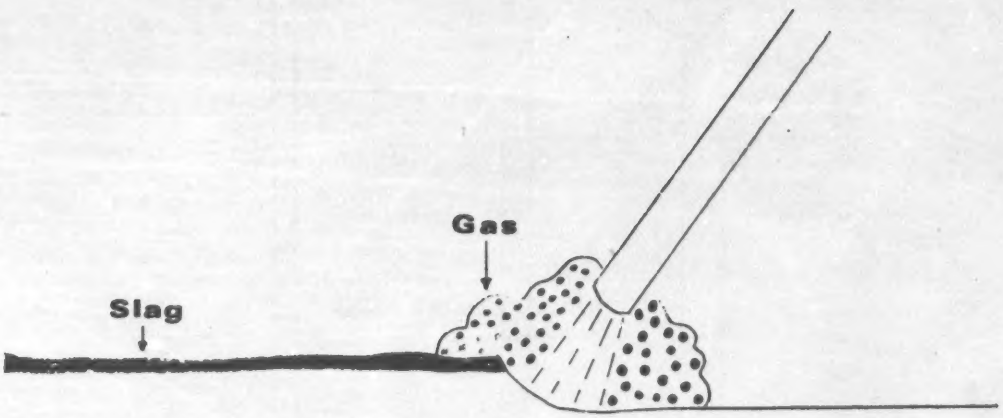
Electrodes having a soft arc with light penetration are usually used with thin/light metals. They penetrate very lightly and produce minimal heat. These electrodes with a soft arc and light penetration are frequently used with light, thin metals like this welded piece of aluminum. They leave a smooth, neat appearing fusion over the welded metal.

| Classification | Current | Arc | Penetration | Covering & Slag | Iron Powder |
|---|---|---|---|---|---|
| EXXX1 | AC & DCRP | Digging | Deep | Cellulose-potassium | 0 |
| EXXX2 | AC & DCSP | Medium | Medium | Rutile-sodium | 0-10% |
| EXXX3 | AC & DCS & R | Soft | Light | Rutile-potassium | 0-10% |
| EXXX4 | AC & DCS & R | Soft | Light | Rutile-iron powder | 25-40% |
| EXXX5 | DCRP | Medium | Medium | Low hyd.-sodium | 0 |
| EXXX6 | AC or DCRP | Medium | Medium | Low hyd.-potassium | 0 |
| EXXX8 | AC or DCRP | Medium | Medium | Low hyd.-iron powder | 25-40% |

The next area on the chart, covering and slag, refers to the substances which coat the electrode. These coatings do much to improve the quality of the weld.



This drawing shows an electrode which has been split in half. The white area in the middle is the bare electrode metal. The shaded area is the electrode's coating. The coating is different substances which are painted or sprayed over the bare electrode.




This picture shows how the electrode's covering and slag improves the quality of the weld. Part of the electrode's coating burns in the heat of the arc making a gaseous shield around the arc. This is the dotted area in the picture. The shield keeps air away from the melting weld because air lowers the weld's quality. Another portion of the electrode's covering mixes with impurities in the metal and floats them to the top of the weld where they cool forming a covering called a slag over the melted metal. The slag is the shaded area in the picture. The slag also keeps air from the molten metal and it helps the metal cool. After the metal cools the slag may be chipped away with a slag hammer.

| Classification | Current | Arc | Penetration | Covering & Slag | [illegible] |
|---|---|---|---|---|---|
| EXXX1 | AC & DCRP | Digging | Deep | Cellulose-potassium | 0 |
| EXXX2 | AC & DCSP | Medium | Medium | Rutile-sodium | 0-10% |
| EXXX3 | AC & DCS & R | Soft | Light | Rutile-potassium | 0-10% |
| EXXX4 | AC & DCS & R | Soft | Light | Rutile-iron powder | 25-40% |
| EXXX5 | DCRP | Medium | Medium | Low hyd.-sodium | 0 |
| EXXX6 | AC or DCRP | Medium | Medium | Low hyd.-potassium | 0 |
| EXXX8 | AC or DCRP | Medium | Medium | Low hyd.-iron powder | 25-40% |

The last category on the chart, iron powder, indicates the percentages of the electrode's coverings weight which is iron powder. Iron powder improves the welding speed and it makes slag removal easier. The electrode coverings on the chart range from zero percent to forty percent iron powder.

# E6012

In summary, the capital letter E indicates that it is an electrode identification number.

E[redacted]12

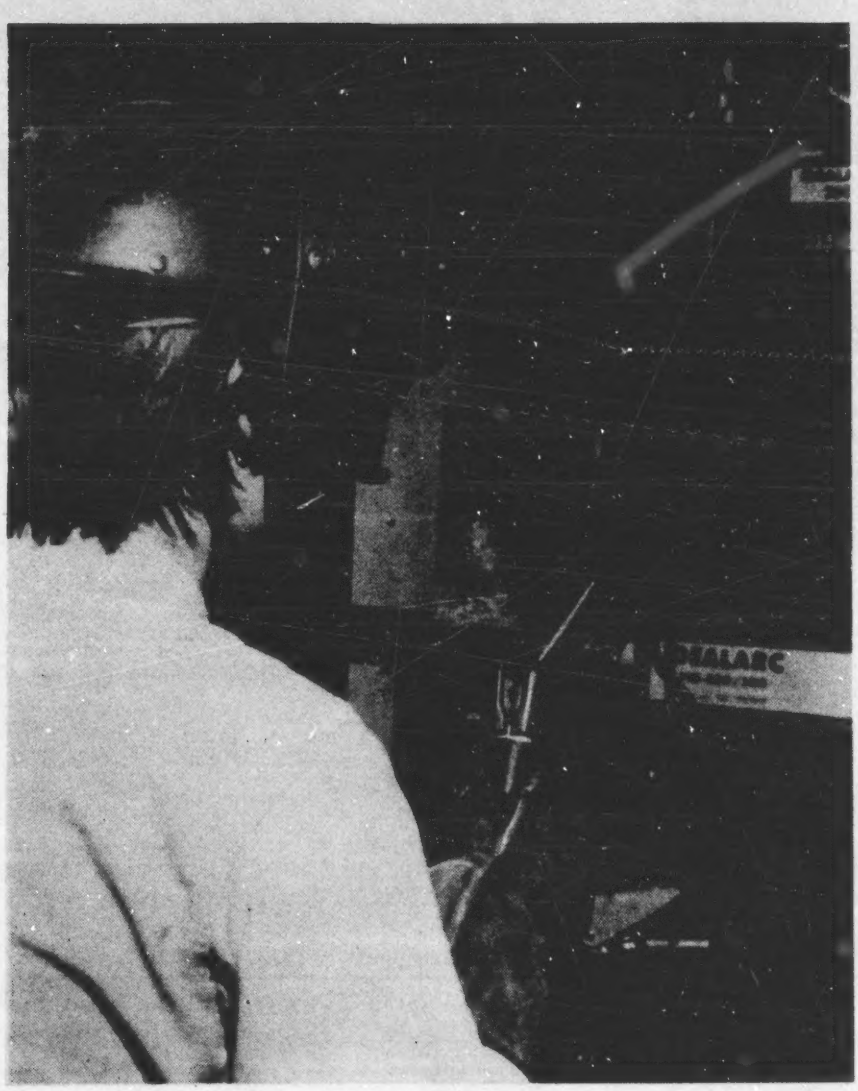
The first two, possibly three numbers tell about the electrode's tensile strength.

# E6012

The second last number tells in what positions the electrode can be used.

# E6011

The last number combined with a welding chart relates to current, arc, penetration, covering and slag, and iron powder.



Now that the presentation is over, it would be a good idea for you to take a look at some of the welding equipment we discussed. Take a look at the different power sources, electrodes, electrode containers, and electrode identification charts which are being used in your welding area.

# Glossary of Welding Terms

*Note to Teachers:* This Glossary of Welding Terms can be used by students, as they use the Identifying Basic Welding Terms: Electrode Identification Numbers workbook and tape. Teachers may ask students to look at the glossary before using the workbook, as they are studying, as a review of the lesson, or at all three times. These terms can also be put on flash cards or language masters which the students can use to practice terms independently until becoming more familiar with them.

**Alternating Current (A.C.)** — the flow of electrons from the negative to the positive terminal, then the positive to the negative terminal in an electrical circuit.

**Arc** — the bright hot glow between the electrode and the base metal made when the electrical current has to jump through the air. There are 3 types of arcs - digging, medium and soft.

**Base Metal** — the metal with the gap or break that is to be welded.

**Covering** — the outside coating of the electrode which is made of different substances which are painted or sprayed over the bare electrode.

**Direct Current (D.C.)** — the flow of negative charges called electrons in the same direction all the time in an electrical circuit.

**'E' Number** — Electrode Identification Number, the 4 or 5 numbers following the letter 'E,' each indicating some information about using the electrode in welding. This number helps the welder pick the best electrode for the job.

**Electrical Current** — the flow of negative charges (called electrons) through a circuit.

**Electrode** — a metal wire or rod used to fill a gap or break in metal. When heated, the electrode and the base metal melt together into a liquid-like pool.

**Fusion** — after the melting together of the electrode and the base metal into a liquid-like pool, the metal cools and hardens, holding the two pieces of metal together.

**Gap** — distance between two pieces of metal which is to be filled as the electrode melts.

**Iron Powder** — a substance present in the electrode covering which improves the welding speed and makes slag removal easier.

**Penetration** — how deep the electrode and base metal melt together into the base metal. There are 3 basic types of penetration - deep, medium and light.

**Reverse Polarity** — when the electrical current runs from the work being welded to the electrode.

**Slag** — the mixture of the electrode's covering and impurities in the metal which floats to the top of the metal. After the metal cools, the slag may be chipped away from the welded metal.

**Straight Polarity** — when the electrical current runs from the power supply to the electrode and then through the work being welded.

**Tensile Strength** — how much pulling pressure the electrode can withstand before it breaks.

**Welding Positions** — there are 4 basic welding positions: flat, horizontal, overhead and vertical.

## WISCONSIN VOCATIONAL STUDIES CENTER

The Wisconsin Vocational Studies Center at the University of Wisconsin-Madison was reorganized with the support of the Wisconsin Board of Vocational, Technical and Adult Education within the School of Education in 1971. The function of the Center is to serve the State of Wisconsin in a unique way by bringing the resources of the University to bear on identified problems in the delivery of vocational and manpower programs-vocational education, technical education, adult education, career education, manpower training-to citizens of all ages in all communities of the State. The Center focuses upon the delivery of services including analyses of need, target groups served, institutional organization, instructional and curriculum methodology and content, labor market needs, manpower policy, and other appropriate factors. To the extent that these goals are enhanced and the foci of problems widened to encompass regional and national concerns, the Center engages in studies beyond the boundaries of the State.

Merle Strong, Director
Roger Lambert, Associate Director

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***964 Educational Sciences Building***
***1025 West Johnson Street***
***Madison, Wisconsin 53706***